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ESCALATION PROVISIONS FOR NAVY CONTRACTS ISSUES AND CHOICES

by

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This paper begins with the identification and exposition of the four major issues involved in escalation for Navy contracts. These issues are: Why is the change in input prices a particular problem for Navy contracts? Why is escalation a good procedure for dealing with the problem? What are the possible side effects of using escalation procedures? and, How is the trade-off between administrative cost, accuracy and contractor incentives (moral hazard)

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reached? For each seperate issue as well as for the set of interrelated issues a discussion indicating its general applicability as well as its specific applicability to individual case is given.

After the issues discussion the area of implementation of escalation is considered as a series of four questions: What prices should be covered? How should the price changes be measured? When should the measurements be made? and, How should the price changes be compensated? These questions are given general answers in each case and the set of questions as a whole is also considered.

EXECUTIVE SUMMARY
ESCALATION PROVISIONS FOR NAVY CONTRACTS: ISSUES AND CHOICES

BY

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Payment of escalation for Navy contracts raises four major issues:

- Why is input price change a particular problem for Navy contracts?
- Why is escalation a good procedure for dealing with price changes?
- What are the possible side effects of escalation?
- Can escalation provisions be made which reach a proper trade-off between administrative cost, accuracy and the contractor's incentive to minimize cost?

The complete solution of these issues must be in the context of particular acquisitions. For each of these acquisitions, a series of choices must be made:

- What prices should be covered?
- How should price changes be measured?
- When should the measurements be made?
- How should the measured changes be compensated?

The presentation of issues and choices is an important first step in addressing escalation and will be followed by additional investigation. Quantitative models of the effect of escalation have been formulated but are not addressed in this paper. Also, the question of whether escalation promotes general economic stability or instability remains moot. Finally, there are interfaces between the question of escalation for contracting and the budgetary process and with general DOD-industry profit policy which also remain to be investigated.

ISSUE 1: WHY ARE PRICE CHANGES A PARTICULAR PROBLEM IN NAVY CONTRACTS?

This issue is implicitly addressed in the paper. Standard commercial practice is that sellers include anticipated input price changes in their selling price. Why should special procedures be necessary in the Navy? The answer is in the nature of the development and production of weapons.

The U.S. technological advantage in weapons systems has been accompanied by a departure from the ancient market practice of letting the

producer design, test and produce the item which is then purchased by the buyer. Because of the limited number of customers, the producer's imperfect knowledge of the customer's need and the high investment in developmental and working capital which would be required, the military has instead contractually promised cooperation in the design and test process and promised to pay for the resulting systems long before the weapons exist. There may be alternative solutions but in this paper we are forced to consider the long periods of uncertainty under Navy weapons systems contracts, for example 8 years for the CVAN-68.

ISSUE 2: WHY ESCALATION FOR PRICE CHANGES?

Escalation is the explicit contractual treatment of price change in which the contract price is adjusted after price changes are measured. Thus input price uncertainty is removed or reduced. Because decision makers avoid uncertainty, the escalation approach is attractive to both parties to the contract, as demonstrated in Chapter I. The major alternative to escalation is contingency pricing where the contract price includes anticipated inflation. In times of changing rates of inflation or deflation this anticipation is quite difficult. Since major weapon system contracts are large, long and infrequently awarded, the penalties of even one incorrect prediction can be substantial compared to the net worth of the contractor. Contingency pricing is not an attractive alternative under these conditions. Other alternatives to escalation addressed in Chapter I have serious shortcomings for Navy weapons systems contract.

ISSUE 3: WHAT ARE THE POSSIBLE SIDE EFFECTS OF ESCALATION?

Although escalation appears to be an attractive device for dealing with price changes during a contract, there are potential problems when addressed from a wider viewpoint.

One question is how to budget for price changes. Because escalation is an explicit acknowledgement of a price change, inflation will cause a "cost overrun" if an overrun is defined as any increase over the contract's target price. Contingency pricing provides a cushion of predicted price change which may even allow cost-overruns from other causes to be disguised if input price changes are less than predicted. Thus the apparent budgetary outcome can be significantly affected by the choice of handling price changes in the contract. This problem could be solved in the shipbuilding appropriations category by separately funding an aggregate of escalation, which would not be the fault of the individual ship projects. Recent Congressional reporting procedures for each project may make this treatment less viable. Study of this issue continues and will be addressed in a later paper.

The other potential side effect is the possibility that wide-spread escalation may encourage general price inflation. Arguments can be given either way on this issue and it is unlikely that anything short of experimentation would answer the question. With DOD expenditures at 6% of GNP it is doubtful that Navy actions alone can substantially endanger the economy however.

ISSUE 4: CAN A SATISFACTORY TRADEOFF OF ADMINISTRATIVE COST, ACCURACY AND CONTRACTOR INCENTIVE BE REACHED?

Even though escalation clauses are conceptually beneficial, the practical implementation will require that the cost of administering escalation provisions must not exceed the benefit. Customary escalation procedures are quite simple but are moving in the direction of complexity. This complexity is a response to the fact that recent inflation has made the monetary value of escalation payments rise. The inaccuracies or discrepancies between escalation paid and that incurred by the contractor, which were negligible in periods of lower inflation, are now substantial. As discussed in Chapter III, the difficulty with accurate measurement of the contractor's price changes is that they are more likely to reflect variables that he can control, i.e., his actual labor or material or overhead cost. This potential control raises the incentive or moral hazard issue, that he will be more inclined to allow his input prices to rise if he is reimbursed by escalation payments. The use of indirect measurement through price indices is the major tool to control this behavior, known as moral hazard in insurance, but indices are inherently inaccurate for any particular contractor. The choices in implementing an escalation provision described below are those which will determine how the trade-off is actually accomplished and whether it will be successful.

CHOICE 1: WHAT PRICES SHOULD BE MEASURED?

Several choices are necessary in this area. For most any weapons system an input price index for the contractor should be used rather than an output price index because of the difficulty of identifying equivalent output units over time for ships and aircraft.

Inputs should be measured on the level of aggregate direct material and labor. Indirect labor and materials may be broken into individual cost categories or simply treated as included in labor and material. Escalation of depreciation is recommended as a minimal recognition of the increasing opportunity cost of equipment and facilities.

The depreciation question raises the issue of DOD profit policy which unfortunately is unclear at this time. Escalation of fee, although discouraged by DPC 120 when explicitly addressed, is implicit in contingency pricing since the costs, on which profit is based, are usually increased to include inflation. Explicit nonescalation of fee results in the contractor receiving a lower percentage fee than was negotiated. In addition the fee is paid in dollars with decreased real purchasing power.

An important choice is whether the initial estimate or the actual mix of labor and material will be measured. The use of an estimated mix is favored by the ease of administration and the removal of any incentive for the contractor to change his mix merely to gain in escalation. These benefits may be offset by the inaccuracy of the estimate. Inaccurate prediction of the mix could result from changing

conditions after the negotiation of the contract or from the use of an average mix when a competitive contract is being awarded. Analysis of the extent of the inaccuracy in the ship building mix has been performed by MAT 02 and found to be small in most cases in the recent past [13]. The major inaccuracy that was found was due to schedule slippage, which can be removed through relating the escalation to actual progress rather than an estimated schedule. For this reason, when estimation of the schedule is questionable, actual progress should determine escalation. If actual progress is used the actual mix will be automatically recorded. The actual mix and schedule is therefore favored in any case where prediction of mix and/or schedule is difficult.

CHOICE 2: HOW SHOULD PRICE CHANGES BE MEASURED?

The major choice in measurement technique is that of price indices versus measurement of the contractors actual costs. Price indices are favored by ease of administration and the removal of moral hazard. i.e., the possibility that the contractor will not resist increases in input prices. Again the benefits of price indices may be offset by their inaccuracy for a particular contractor. In such cases the administration cost of the measurement of actual costs should be examined and the degree to which other constraints will keep the moral hazard under control should be evaluated. In some situations these conditions will be favorable and actual costs may be measured for escalation purposes.

CHOICE 3: WHEN SHOULD PRICE CHANGE MEASUREMENTS BE MADE?

The choice of a base date for escalation measurement should be shortly prior to the beginning of the contract to allow contract cost estimating to be based on current prices.

The choice of frequency of observation may be determined by the availability of indices. Otherwise measurement frequency must again be a compromise between added administrative cost and accuracy.

The timing of payment of measured escalation is complicated by the progress payments situation which is currently unclear, at least in shipbuilding. Payment of escalation should be integrated with progress payments to reduce administrative costs. The final choice is whether to cease measurement when some schedule milestone date arrives. This procedure would retain any incentive for early completion that the customary shipbuilding escalation clause is said to provide. This incentive is created because escalation is based on an initial estimate of progress rather than actual progress. Since escalation payments were therefore unaffected by the contractor's actual progress, he has an incentive to purchase his inputs early and thereby avoid inflation. Presumably this leads to earlier completion. "Freezing" the measurement of price change as of the deliver milestone date would provide a somewhat similar incentive. It would also provide incentive for the shipbuilder to negotiate a later delivery milestone. Furthermore, it would not provide incentive during periods of stable prices

and could provide a schedule dis-incentive in periods of price decline. It is therefore not recommended unless an accurate prediction of material and labor price trends is available, which is contrary to the basic suposition of this paper and recent experience.

CHOICE 4: HOW SHOULD THE MEASURED PRICE CHANGE BE COMPENSATED?

The choice involved in compensation is what portion of the measured price change to reimburse the contractor. One choice would be to make the contractor share in the risk of price changes, that is give him less than the measured change. The other extreme is to increase the measured change if the measurement is thought to be biased downward compared to the particular contractor's experience. Forcing the contractor to share the risk contradicts the reason for escalation. However if there were no other way to prevent moral hazard in a particular circumstance, sharing could serve as an incentive for the contractor to hold down input price increases. Multiplying the measurement seems a grossly arbitrary means of adjusting for inadequate measurement.

It has been suggested that the contractor should share in escalation when costs rise above the target cost. Because target cost may be exceeded for a wide variety of reasons or may never be reached, this approach would not serve for prevention of moral hazard. A different technique, the share line, is designed to provide incentive to keep cost below target and functions regardless of inflation rates. It is hard to see what purpose sharing above target fulfills although most current shipbuilding clauses do so.

Through modification of the measurement procedure such as freezing it at the delivery date, the escalation clause can conceivably provide additional incentives. In this case freezing might be an incentive to complete the contract by the delivery date. However, the size of the incentive is unknown because it will depend upon how much inflation occurs. It would also provide a reason for contractors to negotiate later delivery dates, which is already a difficult area. Somewhat similarly, having the contractor "share" in escalation beyond target cost would provide an additional cost incentive but again of unknown amount.

Sharing in escalation over the entire range of the contract could be used as a protection against more hazard, but it would also mean substantial assumption of the risk of price changes by the contractor. However, in cost incentive contracts it is sometimes assumed that a small percentage such as 10 - 20% of cost is enough to influence a contractor.

All of the schemes which would reduce escalation below the amount incurred by the contractor are contradictory to the purpose of the escalation clause, the removal of uncertainty. They all raise the likelihood of contingency pricing by the contractor. Experience with other contract incentives has shown that those which cannot be predicted and which interact with other clauses often cause unexpected problems.

As can be seen by the discussion a large number of choices have to be made. Particular escalation clauses will require fairly detailed consideration. One method for evaluating particular escalation provisions is "gaming" or detailed simulation of what would happen to a contract with a particular clause under a variety of circumstances such as inflation, cost overrun etc. Such models have been developed and exercised in support of negotiations. They are to be the subject of later papers.

ESCALATION PROVISIONS FOR NAVY CONTRACTS: ISSUES AND CHOICES

I. WHY HAVE ESCALATION PROVISIONS?

A. ESCALATION: CONCEPT AND CAUSES

Recent high rates of inflation have focused attention upon mechanisms for dealing with inflation in long-term Navy contracts. Escalation clauses are the explicit contractual provision for inflation or deflation. In this paper, escalation is defined as the contractual amount paid to reimburse a contractor for any measured changes in the price of his inputs during the life of a specific contract. Escalation is referred to as the "economic price adjustment" in DPC 120 [1] but this terminology is needlessly complex. Escalation can be either a positive or negative adjustment. Escalation must be triggered by some measurement of price changes. The measurement of price changes may not discriminate between the possible causes of the change:

1. a general change in price levels - inflation or deflation, i.e., an "economic" change,
2. relative price changes due to supply and/or demand changes,
3. increases in the contractor's input prices resulting from relaxed bargaining with suppliers on the part of the contractor because of the escalation.

The objective of including an escalation clause in a contract is to adjust the contract in response to changes in the general price level, the first cause mentioned above. But inflation or deflation is not the only cause of price changes. The market system operates so that a change in the price of a good can also be the result of a shift in the demand and/or the supply of the good, the second cause mentioned above. The price of labor in an area may increase, for example, when a new brewery opens in the Newport News area. Such price changes are an essential mechanism for allocating resources in the economy. Although the previous example was perhaps disadvantageous to the Navy, the use of similar price changes was to be a major mechanism for attracting labor to the new Litton Pascagoula shipyard, which would be to the Navy's advantage. Both of these rather complex situations demonstrate that we must be very careful to remember that not all price changes have the same cause. Escalation might respond to any price change and so must be carefully used or it could destroy the contractors incentive to adjust to new technology, local supply conditions, etc.

The third cause is a possible effect of the escalation provision itself. The payment of escalation could provide an incentive that reduces the contractor's diligence in holding down the prices of his inputs. This potential often can be avoided by measuring the price changes on a broad scale rather than those of a particular contractor. Usually this is done by basing escalation on the movement of a recognized price index.

In addition, an escalation clause may indirectly affect the behavior of more than just the contractor. It may impinge upon his subcontractors, (with or without pass-down clauses) his labor unions, his competitors in the industry and even the government or Navy itself. For simplicity we will usually refer to the contractor only, but the indirect effects can be very important and should not be overlooked in any specific application of escalation clauses. This wider viewpoint is also reflected in some opinions that widespread use of escalation could contribute to macro or total economic system price instability. On the other hand some feel that escalation is useful in preventing further price increases by reducing uncertainty. A recent issue of the Federal Reserve Bank of St. Louis Review addresses both sides [2]. This paper will not deal extensively with this question because it is a major unknown at this time. With regard to the three causes, this paper will most heavily address inflation. The other causes must be kept in mind in order to formulate escalation provisions which remove uncertainty of inflation without providing dis-incentives for response to relative price changes or to resist input price increases.

This paper identifies the choices which must be made when an escalation clause is to be implemented. Later papers will describe models for decision-making in those choice situations. First the objectives of the escalation clause are established in this chapter.

B. CAN ESCALATION SERVE BOTH PARTIES?

The escalation provisions in a contract must serve the objectives of both parties to the contract, the Navy and the contractor. The escalation provision is concerned with payment for the work to be done, an issue which is too central to any contract to simply be imposed unilaterally by the government. Asking any provision to serve the objectives of both parties may seem difficult but it is to the advantage of both parties to remove the uncertainty in prices from long-term contracts through an escalation provision, as will be seen in this section.

Before beginning the detailed arguments, a quick intuitive version will be given which is intended for those who do not wish to pursue the detailed argument. The objectives of both parties will be discussed below and in detail in sections C and D. Contractors are aware that prices of their inputs change during long contracts. In the face of uncertainty as to how the prices will change, the contractor will usually be conservative and attempt to "cover himself" by estimating a larger price change than actually occurs on the average. However, he still runs a risk if unusual price changes occur. In fact this is probably the origin of the current interest in escalation clauses. Even contractor's conservative estimates have been exceeded by recent price changes. In such times the contractor should prefer an escalation clause which assures him of reimbursement of whatever price changes occur.

From the Navy's viewpoint, the advantage is the savings between the contractor's higher than average estimate of inflation and the "average" price change in the long run. In addition the difficulties faced in abnormally inflationary times such as the recent past, with contractors refusing new contracts and finding ways of "getting well" or abrogating old contracts, would be avoided. Implementation of these advantages to both parties may not be easily reached however, as will be discussed in later chapters. Moreover there are wider viewpoints possible than just those of the parties to the contract, as will also be discussed.

C. THE CONTRACTOR'S OBJECTIVES

The contractor is assumed to be an expected utility maximizer and to be risk averse. These two concepts, which are discussed below are somewhat more complex than the usual assumption of "profit maximization" but are necessary if uncertainty is to be explicitly considered.

Suppose a sole source contractor and the government have agreed that the best cost estimate at current prices of a weapon system is C. They have also agreed that a fair and reasonable profit is Π. Now the contractor points out that if prices of the inputs included in C do not rise, he can sign the contract for a total price of $C + \Pi$ and expect to earn Π. But suppose there is uncertainty about input prices. Assume that with probability p_1 prices will not change but with probability p_2 they

will increase to a level such that the contractor's profit decreases by the inflation rate (r) times the cost (C). That is, profit would decrease by rC. In order for the contractor to anticipate an average profit of Π over many such contracts, he would need to have some chance of making more than Π, so as to offset the possibility of increased prices decreasing profit. He can calculate Π_E, the profit required to give him Π on the average as follows:

$$\Pi = p_1\Pi_E + p_2(\Pi_E - rC)$$

or

$$\Pi_E = \Pi + p_2 rC$$

The contractor therefore offers to sign the contract without escalation provisions for $C + \Pi + p_2 rC$. This contract price of costs (C) plus a fair and equitable profit (Π) plus the average impact of price increases ($p_2 rC$) is based on the rationale that over several such contracts he will earn Π.

The paragraphs above demonstrate the average profit approach to uncertainty. Would an escalation provision be more acceptable than the procedure above to the contractor? The concepts of utility and risk aversion are now required. The utility of profit to the contractor is merely some scaling of the dollar profit with an arbitrary zero and some decreasing increment for each dollar, if he is risk averse. The utility of an amount of profit Π, is written $U(\Pi)$ and merely represents a transformation of the constant increment dollar scale into one that show diminishing marginal utility of money. It is therefore true that

$U(\Pi_E) > U(\Pi) > U(\Pi_E - rC)$. Under the previous arrangement, the contractor receives Π_E with probability p_1 and $\Pi_E - rC$ with probability p_2. His expected utility would be

$$U = p_1 U(\Pi_E) + p_2 U(\Pi_E - rC).$$

Suppose an escalation provision is determined that gives the contractor a profit of Π even if prices do rise. He then receives Π with certainty. The utility of Π with certainty is $U(\Pi)$. The two utilities just mentioned, $U(\Pi)$ and $U = p_1 U(\Pi_E) + p_2 U(\Pi_E - rC)$, are equal only if the contractor is risk neutral. That is if he maximizes average profit. But one assumption usually made in introducing utility is that most individual decision makers are risk averse. This means they would avoid taking an even bet. They want some favor in the odds to make up for taking the chance of a serious consequence. This risk averse behavior means that the contractor will prefer the certainty provided by the escalation provision, i.e.,

$$U(\Pi) > p_1 U(\Pi_E) + p_2 U(\Pi_E - rC).$$

The net result is that a risk averse contractor will prefer the contract with escalation. He will prefer a contract for $C + \Pi$ and an escalation clause compared to a contract written to give him an average profit of Π. Another useful way to look at the contractor's choice is that an additional profit $\Delta\Pi$ would have to be paid to make him indifferent between the escalation and profit Π versus the average profit Π with uncertainty. The equation

$$U(\Pi) = p_1 U(\Pi_E + \Delta\Pi) + p_2 (\Pi_E + \Delta\Pi - rC)$$

would define the risk premium $\Delta\Pi$ necessary to make the contractor indifferent between the contract without the escalation provision.

D. THE NAVY'S OBJECTIVES

The objectives of the party to the contract paying the costs, in this case the "government" are listed as follows:

1. to minimize the anticipated cost,

2. to preserve the sources for defense weapon systems, namely the contractors, in order to maintain some competitive benefits, derived from the current industrial structure.

3. to avoid cost overruns,

4. to maintain a stable domestic economy by holding inflation to a low rate.

The Navy contract negotiator's objectives are assumed to be to acquire the needed defense items at the lowest anticipated cost consistent with a "fair and reasonable profit" to the contractor per ASPR. This is because the contract negotiator is primarily interested in the negotiation itself, i.e., the contract, rather than the results of the contract which occur over many years. He is judged by comparing the contract against the approved negotiation position rather than the ultimate outcome. This behavior is at least consistent with objectives one and two listed above. The wider objectives will be discussed later in section G.

Where an escalation provision is included, the Navy's cost will be $C + \Pi$ with probability p_1 and $C + \Pi$ plus the escalation or change in price with probability p_2. The escalation is rC. The average cost with escalation to the Navy is therefore:
Governments as contrasted with individuals, are generally self-insured. Arrow [14] shows that governments should be risk neutral, i.e., cost minimizing.

$$E[C] = p_1(C + \Pi) + p_2(C + \Pi + rC)$$
$$= C + \Pi + p_2 rC \ .$$

Thus the expected cost to the Navy is the determined costs plus a fair and equitable profit plus the average impact of anticipated inflation. In contrast, without the escalation provision, we earlier established that the risk neutral contractor would ask for cost, C, plus Π_E, which is equal to Π plus the expected inflation $p_2 rC$. In addition if the contractor is risk averse, as noted on page 8, he will require an increment in profit $\Delta\Pi$, the risk premium. Thus for the risk averse contractor the cost to the government will be

$$C^1 = C + \Pi + p_2 rC + \Delta\Pi \ .$$

This is obviously greater than the cost with the escalation clause by the amount of the risk premium, $\Delta\Pi$. Thus it is established that the Navy has a lower average cost with the escalation provision and the contractor has higher expected utility, i.e., they are both better off. This general principle of the advantage of escalation clauses will provide guidance.

The discussion above which establishes the advantage of escalation to both parties has certain shortcomings as overall guidance for escalation. First it clearly is limited to a simple abstraction of the contractor. He does not have other contracts or alternative business. His method of financing, which may affect his attitude toward uncertainty, is not addressed. The industry, his competition, has not been introduced. Later papers will provide more detailed models of contractor behavior. We expect that the general result will hold true however.

Second, the discussion above assumes fairly limited objectives for the Navy. Broader objectives such as contributing to price instability and budgetary interactions are more difficult to deal with particularly in an analytical way. However, they are discussed in section G to a limited extent.

E. ALTERNATIVES TO ESCALATION - ESCALATION VERSUS CONTINGENCY PRICING

The scenario in sections C and D is quite simplified and does not quite follow the steps in a typical negotiation. In a negotiation such as a NAVAIR negotiation with an aerospace company, no escalation provision is normally included in the contract. The cost C is determined and then an inflation factor (%) is applied to obtain the total cost, $C + \% C$. Then a profit Π^* is determined on the basis of the inflated cost of $C + \% C$. Since the profit Π^* is on a higher, inflated cost it will likely be higher than Π. In such cases a prediction of the price change reduces the uncertainty before profit is calculated. This is called contingency pricing. The government is committed to paying more than $C + \Pi$. In fact if the contractor is risk averse he will again increase the cost by more than the anticipated inflation "to be on the safe side." This phenomena is somewhat similar to the buffer stock in inventory - a stock larger than the expected demand is maintained.

Contingency pricing does have certain advantages. It is a fairly simple contracting approach since the contract merely addresses "cost" with no mention of how the estimate was computed vis a vis inflation and no necessity for administration. This approach makes it very difficult to obtain any record of how well

contingency pricing actually functions however. Another advantage is that contingency pricing is probably the most common approach to uncertainty in the commercial world. Thus there is wide experience with its use. Therefore, even if a policy was issued to replace contingency pricing with escalation clauses it would not be easy to stop current practice and insure that the replacement actually occurred. The contractor may increase his estimated cost to compensate for inflation and take the escalation clause also. Since cost is the product of price and quantity, the contractor can disguise price changes by mis-estimating quantities of labor hours or materials. Thus the necessity for accurate cost estimating capability by the government if escalation is to be used in non-competitive procurements. This leads to some of the other approaches to price uncertainty as discussed in the following section.

F. OTHER ALTERNATIVES TO ESCALATION

The above approach to price uncertainty is to simply rely on the contractor to correctly estimate price changes or to bear the results of his mistake. In times of stable rates of inflation this is the standard commercial practice and is probably quite adequate. Recent problems indicate that it is currently not entirely satisfactory.

Another alternative would be the creation of a private market for insurance against price changes. This would probably be acceptable to both the government and the contractor. However,

no such insurance is currently available. Presumably this is at least partially due to the "moral hazard" problem in such an insurance policy if a particular contractor's price increases were to be covered. If a more widely-based measure of price changes were used, the problem is that the governmental actions would be such a very large influence on the prices that establishing a statistical or actuarial average change in prices would be very hazardous. The lack of a private market should serve as a warning of this danger.

From the discussion in sections E and F it can be seen that the existing alternatives to escalation are not very attractive in the face of unstable rates of inflation or deflation. For this reason it is worthwhile pursuing the detailed choices required to implement escalation in contracts in order to remove price uncertainty.

G. WHY ARE SOME AFRAID OF ESCALATION?

Why is contingency pricing often used rather than escalation? In section D the objectives of the government were listed and these were noted to possibly be a larger set than those assumed for the Navy contract negotiator in section D.

One objective not addressed was the desire to avoid cost overruns. Overruns are usually defined as all increases beyond the target cost of the contract, which would include escalation payments. Therefore any inflation at all leads to an overrun if an escalation clause is used. On the other hand if contingency pricing is used

to set the inflated target cost, C + % C , no "overrun" occurs unless the assumed rate of inflation is exceeded. The reason for the sudden interest in escalation in the aerospace industry is that actual inflation is exceeding the estimate made in contracts in the preceeding years. The overrun question raises the important relationship between how inflation is handled in contract escalation clauses and how inflation is to be handled in budgeting procedures and accountability for inflation both within DOD and before Congress.

In the shipbuilding appropriation category, where escalation has been customary, each line-item reflects a reserve for inflation, while the Ship Cost Adjustment (SCA) line item reflects difference in this component as well as others in all prior year SCN line item. Thus the individual ship projects have not been held accountable for inflation. This procedure has been complicated by the institution of SAR reports to Congress. A later paper will specifically deal with the relationship of escalation in contracting and in budgeting.

The other objective that is not considered at the level of the Navy contract negotiator is the price stability of the economy as a whole. The widespread use of escalation provisions may contribute to instability. If there are sudden inflationary impacts on the economy such as the recent fuel price change, escalation provisions pass these price changes undiminished throughout the economy and therefore continue the inflation. This may be a more equitable procedure than to allow one sector of the economy to absorb the price change, but it does not necessarily contribute to short-run stability. Walter Heller, exchairman of the Council of Economic Advisors has recently come out against

"indexing" because of this tendency [3].

The effect of widespread escalation clauses on the price stability of the U.S. economy is simply unknown at this time. It can be argued that escalation clauses are in fact relatively stabilizing because they offer industry protection from input price changes. This should reduce the urgency to raise his output price in anticipation of inflation, a phenomena recently observed in the U.S. It will probably require experimentation with clauses in some industries in order to determine the actual effect of escalation on inflation. It is therefore difficult to reject escalation clauses because of their potential contribution to economic instability at this time. We therefore will not further address this issue in this paper.

H. IMPLEMENTATION OF ESCALATION IN NAVY CONTRACTS

The following chapters address the choices required in implementing an escalation clause. In section D above it was shown that in general both the Navy and the contractor could benefit from removing the uncertainty in price changes from long-term contracts by escalation. The discussion ignored any costs associated with administering the escalation agreement and assumes perfect measurement of the actual change in prices. In addition it was stated that the actual price should be outside the control of either party. The last condition may not be entirely met since both the contractor and the government conceivably exert considerable control over prices such as the cost

of labor in a shipyard. For example, the government could order additional ships from the same or nearby yard thereby increasing the demand for labor. Or the contractor might grant the union an extraordinary increase during wage negotiations. One must be very careful to look at particular escalation provisions, examining them to detect situations where it would benefit one or the other of the parties to exert control on the prices, since this clearly might change the benefit of the escalation provision.

Similarly, escalation provisions with costly or burdensome administrative requirements might negate the benefit of escalation. The cost of adequate measurement of the escalation is crucial to whether the benefits exceed the costs. Consequently we must examine the provisions in considerable detail and test any particular provision for low administrative cost, accuracy and freedom from control by either contracting party.

The essence of an escalation provision is an agreement by both parties to wait a certain length of time, measure a change in the price of specified commodities and services, and finally for one party to pay the other party a sum of money to compensate for the change. An escalation provision can thus be reduced to the following essential characteristics:

1. prices to be covered,
2. measurement of the change in prices covered by a contract,
3. timing of the measurement for escalation,
4. formula for compensation for measured escalation.

Each of these four characteristics will be discussed in turn in the following chapters.

II. WHAT PRICES SHOULD BE COVERED BY ESCALATION PROVISIONS?

A. INTRODUCTION

Chapter I established that removal of price uncertainty was desireable for both parties if an escalation provision can be implemented that removes uncertainty without offsetting administrative costs and without inducing the contractor to allow prices to rise. This chapter addresses the first question which simply is what prices should be covered by an escalation clause. First the question of input versus output prices is addressed. Then direct and indirect costs and fee are discussed. Finally escalation of changes to the contract is considered. The general approach is that prices of inputs that are subject to long periods of uncertainty should be covered by escalation in most cases. This includes even the profit or fee which represents the "price" of capital, that is the price of the entrepreneurial and investment inputs.

B. INPUT VERSUS OUTPUT PRICES

First, choice must be made between input and output price indices when formulating escalation provisions. It has sometimes been suggested that a DOD weapons price index be formulated which would contain the weighted prices of weapons systems purchased in a given year, i.e., the output of industry supplying DOD. Although such an index might be of some value it would not be suitable to use in contracts for the purpose of removing price uncertainty, as will be discussed below. Instead the prices of the various inputs of contractors should be measured.

Weapon systems, including their subsystems and individual components, have experienced considerable technological change in recent years. Each unit such as a fighter aircraft or ship now includes many more hours of labor and pounds of material than in earlier years. These design characteristics are quite distinct from the problem of price changes resulting from inflation and prevent in practice the use of changes in unit prices of weapons systems for escalation purposes, since technological design aspects are then "mixed in" with price changes and escalation only deals with price changes.

As for output prices for escalation, there are Navy contracts which contain satisfactory output price escalation clauses. These occur in the basic commodities such as metals. For these products technological change has not resulted in any substantive change in output specifications so an output price per ton of a particular metal can be measured over time and we can be confident that we are measuring the same output item. Moreover the commodities are sold widely under conditions which may be termed roughly competitive. In contrast, weapons systems are often procured under conditions where there is a single buyer, the government, and a single seller, the company. This is known as bilateral monopoly.

It is indeed unfortunate that these two conditions, a standard output unit and competitively marketed products are not true for weapons systems so that output prices could be measured for use in escalation clauses, since output prices have certain

inherent advantages for escalation. They would allow the contractor to substitute one input for another as prices change without regard to the escalation clause. This desireable flexibility was noted in chapter I. They would also allow the government to share in increases in the productivity of labor, increased efficiency and better management changes in packaging and delivery which may occur as prices of inputs vary. In other words, there is a measurement problem concerning the inputs somewhat similar to that of outputs which is noted above. With input measurement the errors may benefit the contractor. However, this effect is judged to be small and predictable and in fact may well already be factored into the contractor's cost estimate.

C. INPUT PRICES TO BE COVERED IN THE ESCALATION PROVISION

Although this would appear to be a relatively important question, there is not much dispute about the prices covered by the escalation provision, with the possible exception of coverage of the fee. Standard commercial accounting practice has led to escalation provisions which address inputs at an aggregate level of direct and indirect material and labor. The prices will be discussed by these types of cost. Particular attention is given to the question of the degree of contractor control over the price of the input.

1. Direct Material and Labor Costs - Estimated or Actual Mix

The direct costs of material and labor are a major share of the costs of weapons systems. The prices of many materials such as basic metals, are outside the control of any one contractor or even an entire industry since they are widely used throughout the economy. By current usage subcontracts are also included in the material cost. These subcontracts costs and labor costs are potentially much more directly influenced by the contractor. On the other hand, the labor force is often highly unionized on a nation-wide basis and structured by skill and length of service. This means that control of labor costs may also not be effectively under the control of any one contractor. Even if they are under his control, most contractors also have contracts without escalation clauses. To that extent, they continue to have an incentive to hold labor costs down.

Typically both direct material and labor are included in the escalation provision. However there still is the necessary choice of using actual cost or an estimated mix of these costs. That is, should the fraction of total cost considered to be material, be estimated once at the beginning of the contract or should the mix be adjusted as the contract progresses? The advantages of using an initial estimated mix of labor and material are:

a. Ease of administration - the mix is specified in the escalation schedule and no additional information is required.

b. Ease of evaluation of bidders - if several bidders are responding to a Request For Proposal (RFP) a standard mix allows easier comparison of the total cost of each proposal with escalation. Then total escalation cost to the government will not vary because of any relative change in prices of material and labor.

c. Freedom from influence on the contractors efficient choices between material and labor.* Ideally, the contractor should not be influenced by the escalation procedure in his choice of extent of subcontracting as was discussed in chapter I. An estimated mix for escalation is irrelevant to his choice. But if escalation is based on the actual mix, and if there is a difference between the change in price for a particular input and the measurement of escalation for its category, the contractor may be influenced in the choice of that input simply in order to collect more escalation. Such behavior leads to inefficient choices of inputs.

2. Indirect Costs

In general,indirect costs, which are a sizeable share of most weapon systems cost, are to be escalated. Under previous regulations it was up to the Navy contract negotiator to determine whether indirect costs should be included, depending upon whether these changed in proportion to the direct costs. Industry cost accounting usually applies indirect costs as a fixed

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*The authors thank Professor Michael Block of NPS, for first pointing out this feature.

percentage of direct cost. Such a practice would indicate that indirect costs should be escalated.

It is quite easy to get confused on this point however, because of the fact that cost is the product of price times quantity. Most of the cost accounting procedures are based on changes in quantity rather than price.

Actual indirect costs may be slower to increase than direct costs because the quantities of indirect services change slowly. But indirect prices usually increase when direct prices increase since indirect prices are predominately the salaries of engineers and supervisors as well as employee benefits. In general, all salaries rise in proportion and many benefits are a fixed percentage of wages. Therefore escalation of indirect materials and services seems appropriate.

In certain Newport News contracts, fringe benefits have been separately escalated. As pointed out in the LMI study [4] the variation year-to-year and contractor-to-contractor in fringe benefits presents considerable measurement problems. If actual contractor costs are measured the moral hazard problem arise. That is, he may increase fringes more than without the escalation.

Another component of indirect cost, although usually less in weapons systems contracts than in commercial contracts, is depreciation. In shipbuilding contracts, in contrast from aerospace, depreciation is often not escalated, presumably because of the contractor's depreciation cost account doesn't change noticeably when prices increase. This is because of the

unfortunate failure of U.S. accounting practice to update asset values of existing firms. The replacement cost of facilities and equipment has risen steeply and so has the opportunity cost. A beginning step to ease this problem would be to allow escalation on depreciation. However, selection of an appropriate index is difficult. The next section addresses additional aspects of this problem.

3. Escalation of Fee

There is a prohibition on inclusion of fee in the escalation agreement in Defense Procurement Circular 120. This might end any discussion of this item if ASPR contained a satisfactorily implemented profit policy. However there is considerable opinion that profit has been either inadequate inequitable or both, [5,6,7]. We cannot solve the entire profit policy problem in this paper. We shall only indicate the need for a policy which does consider the effect of price uncertainty on profit.

This question revolves around the uncertainty of the real (deflated) value of a fee which is negotiated as a percentage of cost in base year dollars but is specified in the contract and paid in dollars during execution of the contract. When inflation occurs, these dollars represent 1) a smaller percentage of the escalated cost of the contract and 2) will be worth less in real dollars than the fee computed at the contract signing.

The effect of price uncertainty is particularly acute if the contract is an incentive fee contract because the fee may

be reduced through no fault of the contractor. It is also a problem in cost-type contracts where escalation of material and labor cost is not a problem, since full costs are reimbursed as incurred. We will first discuss together the fixed-price and cost-type contracts, then incentive contracts in the following paragraphs.

In a cost-type contract the percentage fee is determined by negotiation in accordance with the formula of "weighted guidelines." The total fee is entered in the contract as a fixed fee in dollars rather than a percentage. The actual payment of the fee is usually made monthly as the negotiated percentage of the cumulative costs incurred to date. If there is inflation, the negotiated fee will be realized in dollars but not as a percentage of escalated costs, unless the total costs are kept within the original target by some approach such as changes in the specifications.

In addition, the fee is paid over the life of the contract and therefore is subject to general price increases which result in the contractor receiving a "deflated" fee, i.e., it is worth less in real terms.

There are several possible results of this problem. 1) The contractor anticipates the inflation and "contingency prices" his costs (or bid in a fixed-price contract) to obtain his desired real fee. 2) The contractor through ignorance of inflation or through competitive pressure does not adequately contingency price and receives a deflated fee. 3) The contractor

turns down the weapon system contract because he cannot anticipate an adequate profit. This later case is most likely when there is alternative commercial contracting available.

The first result, contingency pricing, is just an extension of what happens if material and labor are not escalated. The same disadvantages hold true. It is hard to see any advantage to not escalating the fee if this is the alternative.

The second result is the common one currently as well as in the recent past and probably accounts for much of the industry complaints about low profit, claims, etc. This in itself might not be so serious at least to the Navy, if the second result didn't have a great tendency to lead to the third result.

If there is alternative businesses available to the contractor, he is unlikely to continue taking long-term Navy contracts when earlier contracts have yielded an unsatisfactory profit. The most blatant example is the refusal of Newport News to perform under the options in the 1968 contract for additional DLGN-class nuclear frigates. If these contracts are renegotiated the profits in dollars on the escalated costs will be much higher in dollars. The NMARC study has recently suggested escalation of option prices.

In the long run, inadequate profit will have even more serious effects. Some contractors have sizeable investments in special facilities and capabilities for naval contracts. If returns are sufficient to attract these contractors to further Navy business, it is likely that dis-investment will occur at substantial long-run cost to the Navy, in time, dollars and effective platforms.

In the case of contracts with cost incentives, inflation over a period of years can make the incentive provision inoperative. Accurate estimation of the target cost is the key to any incentive structure. If unexpected inflation raises actual costs, the contractor will receive a negative incentive payment conceivably wiping out any profit on the contract. An escalation provision can be used to cancel the demotivating effect of inflation on the ability of the contractor to meet the target and earn his incentive. If only the fee is not escalated, the incentive structure will not be distorted by an inaccurate target cost. However, the motivational effects of the deflated fee may be much smaller than anticipated. Over an 8-year contract the fee may loose most of its value at current rates of inflation. An incentive contract is based on the principle that small changes in fee have motivational effect on the contractor. If this is true, escalation of the fee would seem important to preserve the incentive structure.

It would be quite easy to base escalation on the total of cost plus fee in order to remove this problem. This would protect the real value of the fee. This change has been opposed at least partially on the basis that this would be a fee awarded as a percentage of cost. Cost-plus-a-percentage-of-cost contracts are disallowed by statute. But it should be noted that the contingency approach already does this in fact. It would seem quite possible to interpret ASPR in a way to resolve the problem as discussed below, or to amend statute to allow full escalation as a fee based on cost plus percentage of price. This would mean only a small dollar change in total cost since escalation of fee would be

perhaps a few percent of the total cost even with high inflation, since the fee itself is usually about 10%. However, this past year for example, there might be a twelve percent change in fee, which is quite considerable to the contractor.

It may be quite unnecessary to change ASPR but merely to properly interpret it. Since profit policy is not well developed in ASPR, as noted earlier, it may be argued that fee or profit actually refers to "real" fee. After all, the contingency pricing technique practiced by negotiators for many years does exactly that because it uses inflated costs as the basis for determining the fee. Contingency pricing is not explicitly addressed in ASPR, but ASPR did evolve over a time period when contingency pricing was the main method used to "cover" inflation.

4. Changes

In many contracts for major weapon systems, the changes to the contract consisting of engineering changes, increases in spares or support, and technological changes in mission requirements have increased the original cost by a significant fraction. In general the escalation policy has been to consider these changes as not subject to escalation. The escalation schedule has been keept unchanged for administrative convenience. This could produce significant under-compensation for input price changes. This potential is offset by two factors:

a. Usually engineering changes are developed and implemented during a short time interval. They occur after the contract has begun as changes are found necessary. Often they are for work to be performed almost immediately so inflation does not have much time to affect the cost of the change.

b. Often the changes are "fully forward priced," i.e., the estimated inflation is included in the negotiated cost of the change. This of course raises the question of contingency pricing again.

In certain contracts, such as the DLGN, escalation is based on the "projected final cost" or "floating billing base" which does include changes, at least conceptually. Projected final cost is obtained by dividing cost incurred by percent contract completed modified by the escalation multipliers. Although this is based on the physical progress concept which may be passing from the scene, a similar procedure could be included in escalation agreements in contracts based on the cost incurred for measuring progress.

D. SUMMARY

Escalation seems logically applicable to all the inputs which make up the cost of the weapon system to the Navy, including fee. Experience gives guidance on how to aggregate the prices. Elimination of some elements of cost does now occur when escalation provisions are made but not in contingency pricing. ASPR lacks a uniform policy on profit, which makes escalation of the entire price of a contract more essential.

III. HOW SHOULD PRICE CHANGES BE MEASURED?

Previously this study has stated that the price level changes due to inflation and the use of long-term, fixed-price contracts by the Navy introduces uncertainty in contracting. The uncertainty resulting from the changes in price levels leads to contingency pricing by defense contractors. It has also been stated that both parties to a contract would prefer the lower uncertainty if a method to measure price changes was incorporated in an escalation provision in the contract. Two major methods to accomplish the measurement of price changes which occur during the contract period are indexation and the determination of actual input prices the contractor pays. Indexation avoids problems of control of price changes by the contractor but with the disadvantage of less accurate measurement of the contractors cost.

A. INDEXATION

1. The Index Concept

The United States General Accounting Office has defined a price index as a ratio of prices at one time or place to those at a previous or subsequent time or place selected as the base [8]. An index that relates to a single item is called a simple price index whereas an aggregate price index relates to a group of items. The two most widely known indices, the Consumer Price Index (CPI) and the Wholesale Price Index (WPI) are aggregate price indices. Aggregate price indices are based on the price fluctuations of a large collection of items, often

called a market basket, which are selected to reflect the price change of the group from which they were selected.

Any aggregate index must choose a particular set of quantities of each item to be included in the market basket. These quantities then serve as the weighting by which the price of each item is multiplied in determining the total value of the market basket. The usual question is whether to use quantities representing those consumed in the base year of the index or in the current year. Administratively, base year weightings are simpler and are used in the WPI and CPI. The WPI or some subset is often specified in escalation clauses for material. It is quite possible then that the materials in the WPI will be weighted differently than is the current custom in any one industry or for any one contractor. Thus indices are never perfectly matched with a contractor's costs. Forecasts of the WPI and CPI indices are available however, so contractors often make use of indices even in contingency pricing.

2. Index Criteria

An acceptable index must relate closely with the type of contractor's cost being measured but also should be broad enough to eliminate the influence of a particular contractor or his subcontractors. Indexation is the major technique used to remove the escalation payment from the control of the contractor. If an industry is dominated by sales to DOD it may even be important to have sufficient breadth to avoid control by the one industry.

Although broad, the index should not be significantly changed by items not in the contractors market basket. For example, in measuring the price change of steel that a shipbuilder experiences, an index limited to shipbuilder's steel plates would not be desired because other steel products are also used. It would be desirable to measure a category more limited than all metal products because a shipbuilder does not use all metal products. The selection of an index is a delicate compromise between breadth to avoid contractor control and specificity to be relevant to his costs.

3. Detailed Index Construction

The determination of the particular indices for a particular weapon system depends upon the specific mix of materials and labor and the level of the industry.

For material, the WPI components by industrial commodity group can be chosen as appropriate. For labor, the Bureau of Labor Statistics (BLS), which also compiles the WPI, conducts wage surveys by industry and region according to the Standard Industrial Code (SIC). In addition a geographical distinction might be made by use of the CPI as an adjustment to the BLS industry-wide measures for labor, as discussed in the appendix.

Indexation of material and labor has been generally successful in shipbuilding and Hazlett [9] has recently determined indices for overhead costs of the aerospace industry. Indirect costs, subcontracts and energy costs are more difficult. In general the approach has been to assume that these follow the direct costs which are more easily measured.

B. CONTRACTOR'S ACTUAL INPUT PRICES

The second method that could be used to accomplish the measurement of price changes during a contract period is the determination of the actual prices the contractor pays for inputs. This method is less general than indexation and offers two advantages:

1. Determination and compensation of actual price changes removes price risk from the contractor.

2. Actual prices can be as accurately determined as resources for measurement permit, reflecting each individual contractor's particular environment.

The disadvantages incurred by using actual prices could include:

1. Reduced incentive for a contractor to aggressively bargain during both wage negotiations and material procurement.

2. Confusion resulting from definitions of which costs are covered and the interpretation of the definitions by individual parties to the contract.

3. The documentation could prove to be administratively burdensome.

4. From the Navy's viewpoint comparison of contractor bids in different environments might prove difficult. One selection procedure would be to base cost distinctions only on each contractors current costs. However, it might be known that one contractor's costs could be expected to rise more rapidly than another's. Should he be penalized in the source selection procedure? If not, Congress will complain. If so, projected escalation will have to be estimated for each contractor. These estimates would be subject to distortion because of the competitive negotiations.

These advantages and disadvantages enumerated above are discussed in more detail in the sections that follow.

1. Advantages

The above advantages over indexation obtained by determining actual contractor costs are interrelated. A contractor who is compensated according to the actual prices he experienced,would incur no price risk. His actual input prices can be accurately determined so that any price changes would be measured and reimbursed.

If only current costs were considered in source selection, an individual contractor would not have to consider his input price position in relation to other contractors as with indexation, since his particular economic environment would be measured by the actual prices he experiences. Relative changes in the geographical and regional differences would also be removed as a consideration in bidding by the contractor. The effect of an individual contractor's relationship in time to the cycle of labor negotiations would also be eliminated when developing a bid for the government. These advantages, most of which benefit the contractor, are not realized without the addition of some disadvantages also. These are discussed in the next section.

2. Disadvantages

The removal of price risk from the contractor could have an effect upon his performance. A contractor who realizes that all of his actual price changes will be compensated could develop a tendency of less aggressive bargaining during wage negotiations and material procurement, if the

escalated contracts are the vast majority of his business. The knowledge that increased prices are passed on to the government without reducing his profit could be an intangible factor during bargaining sessions.

In order to incorporate actual price determination into government contracts, many technical definitions of unit prices would have to be implemented. Prices vary between contractors according to quality, quantity, and mix of materials. Inventories contain similar items purchased at different prices. Various accounting procedures also allocate costs to different activities. Particularly difficult would be prices in the subcontracting and indirect cost areas. Perhaps it would be necessary to again assume these change in proportion to direct prices. If so, the advantage of precise measurement is lost.

The parties to a contract could easily interpret the definitions and provisions differently and/or incorrectly. Legal entaglements and lawsuits could be a result from the inherent confusion. The delineation of exactly which prices are to be included not only would create confusion but also could give the contractor an impetus to change procurement and accounting procedures to include costs which otherwise would not be covered by the contract.

For a large defense contractor, such as Newport News, the documentation of actual costs could prove to be overwhelming. The detail to which costs are documented is the crucial factor. Documentation procedures that require an administrative effort which would cost more than the benefits realized should be

rejected. For the actual costs method to function properly a level of aggregation of cost documentation that is satisfactory for both contracting parties must be developed.

A documentation procedure acceptable to both parties could be most easily negotiated under non-competitive bidding. In contrast, competitive bidding under actual cost provisions would be more complex. For example, one contractor might submit the low bid for unescalated costs but due to geographical, labor contracts, or other circumstances he would not be the low bidder after actual price considerations determined the actual escalated cost. The government would have to develop methods to weigh these factors before implementing actual price provisions into competitive contracts.

C. COMPOSITE OF INDEXATION WITH ACTUAL PRICES

An alternative to pure indexation or to pure actual price determination is a method which incorporates some aspects from both of the previous two methods. Such an alternative may allow the advantages of the other two methods to be realized without also experiencing the related disadvantages.

For example, an escalation provision that incorporates actual prices but still maintains incentive for aggressive bargaining could be constructed with the index as an upper bound. The government could agree to pay the contractor his actual prices as long as they were lower than the unescalated price times an agreeable BLS index. If his actual costs were higher than the target price times the BLS index, then he would

only receive the latter. In this way, the contractor would have incentive to pay increases no larger for labor and material than the average firm's experiences.

This method would allow for easier comparison of bids in competitive bidding. The target prices of each would be the deciding factor since each contractor would receive actual prices or a maximum of target price times the index agreed to in the contract. The maximum would be the same for each contractor.

The method combining both indexation and actual prices allows consideration for an individual contractor's particular situation. If his circumstances allow him to produce a weapon system at cost increases less than the average and still maintain an adequate profit margin, then he could perhaps capitalize on the situation in bidding. The government would then also benefit by obtaining a weapon system at lower cost.

D. SUMMARY

Measurement of price charges is essential to escalation. A compromise between accuracy and the moral hazard of measuring the contractors actual price changes can be reached through indexation. Indexation provides a means of measuring general price level changes without distorting the contractors response to relative price changes. It also removes much of the possible disincentive towards a relaxed attitude to price increases by the contractor although perhaps not to the entire industry to which the index applies.

IV. WHEN SHOULD MEASUREMENTS OF PRICE CHANGE BE MADE?

A. INTRODUCTION

The question of the timing for the measurement of the amount of change of the predetermined prices can be broken down into questions of:

1. The time of the base period or base date,
2. The frequency of observation or measurement of the price changes,
3. The time lag between measurement and payment of the escalation,
4. Whether the measurement should be stopped at some time before completion.

Each will be examined in the sections below.

B. TIME OF THE BASE PERIOD OR BASE DATE

Establishment of the base period for contract escalation is not generally a difficult question. It should be a time before the contract initiation in order to allow the contractor to base his cost estimate on known costs. This typically requires a base period several months prior to issuance of the RFP for competitive contracts or prior to contract signing for sole source contracts. DPC 120 gives virtually no guidance on this point.

The choice of an early base period for measurement of escalation will cause a higher fraction of the total cost of the weapon system to be classified as escalation as compared to basic cost. Escalation, as noted in Chapter I, is a category of cost

overrun which is often held to be outside the project managers responsibility. The choice of early base period has been utilized by some project managers to their advantage.

C. FREQUENCY OF OBSERVATION OF INFLATION

The question of frequency of observation of the measurement is affect by three principal concerns or criteria:

1. The attempt to remove price uncertainty by closely matching the cost incurred with the escalation paid.

2. Administrative effort. This criteria somewhat conflicts with the first since administrative effort increases with frequency, which raises accuracy.

3. Another concern is that the contractor not be encouraged to "game" the escalation provision or negotiation.

High frequency of measurement of escalation would allow the tracking of the prices the contractor is paying throughout the contract. This would allow escalation to offset any inflation, if measured accurately. However, frequent measurements take more administrative effort. At the other extreme if only one measurement of escalation was taken, say at the end of the contract, it would be necessary to estimate the relationship between the rate of inflation during the period and the contractor's rate of expenditure. For example, if a two-year contract had final labor price change of twenty percent above the base period, it could be crudely estimated that the contractor had incurred ten percent inflation on the average and should be given escalation of ten percent of the total cost of the contract. However, the contractor may have incurred the labor primarily during the second year. If so, the escalation based on the average may not

compensate him for the price increases he had to pay. DPC 120 states "Adjustments should be of such frequency so as to afford the contractor appropriate economic relief without creating burdensome administrative effort." The frequency of observation could be varied to match the rate of expenditures. However, that presents difficulties in the availability of indices on the right date and in case of changes or slippage in the schedule.

Shipbuilding labor escalation is often paid quarterly, although it is paid on an estimate of the quarterly labor rather than actual labor. An estimated curve of percentage completion versus time is agreed upon at the signing of the contract. Of course, it is still necessary to make the assumption that inflation and rate of cost incurred are matched within the quarterly period. In fact the current shipbuilding escalation provision assumes that the cost is incurred at the end of the period since full coverage of the inflation up to the point of measurement is provided. In periods of inflation a contractor is encouraged to incur his expenses early by this arrangement, or by any arrangement not based on his actual expenditures; he will incur less price change, by purchasing earlier, while the escalation he receives is unaffected by his early purchase.

One result of the current system is that it provides an incentive for early completion of at least the major portion of the work by the contractor, as mentioned above. This may be a very valuable incentive because the current shipbuilding contract does not effectively penalize the shipbuilder for delays

in delivery. On the other hand, the shipbuilding delays are often the fault of the Navy. The contractor wants to finish and be paid. During periods when the industry is operating at full capacity he is eager to clear the ship out of the yard because it is tying up his capacity. During other periods it may be to his advantage to keep work in the yard while waiting for additional contracts. The current escalation provision provides some incentive for him to complete most of the work early. A related point is addressed in section D.

D. TIME LIMITATION ON MEASUREMENT

As noted in section C, the current escalation clause provides some incentive for the contractor to complete his work on schedule; if not early. If the escalation clause is made more flexible in the direction of reimbursement for the change in price whenever the contractor incurs the cost, this incentive will be lost. It has been suggested that some incentive could be retained by freezing the measurement as of the scheduled completion of the contract. This might provide a small incentive for completion of the majority of the work by the scheduled delivery date but would also provide an incentive for the contractor to negotiate later delivery dates. Other means of establishing delivery incentives are available which would not invalidate the removal of price uncertainty from the contract as this would. Freezing the measurement would be a small incentive if there were low inflation and could be a very large penalty

if inflation were severe. This variation in penalty is essentially independent of the Navy's urgency for delivery. It therefore seems an inappropriate answer to the problem.

E. TIME BETWEEN MEASUREMENT AND PAYMENT OF THE ESCALATION

Another question regarding timing of the escalation measurements concerns the relationship between the measurement and payment of escalation and the other payments to the contractor. DOD makes payment to contractors before delivery in order to reduce their financing costs. These payments are generally called progress payments. The measurement and payment of escalation might be timed to coincide with progress payments in order to reduce administrative costs. The new DPC 94 progress payments provision [10] effectively does this. However, since the new provision has yet to be implemented in shipbuilding, a brief discussion of the older system is in order.

Major DOD contracts provide for progress payments of eighty (80%) of costs. Until recently this has been interpreted as 80% of the cost of work completed, rather than of actual cash outlays. In shipbuilding, an estimate of physical progress for each of material and labor is submitted by the contractor. Payment of up to 95% of the product of that completion percentage and the original contract price less performance reserves is paid to the contractor. Progress payments are permitted as frequently as twice weekly. Escalation payments were made quarterly, based upon the measurement as applied to the contract curve for labor and for material, unless a floating billing base clause is included. Therefore in periods of inflation the contractor (or

others) carried up to a three month investment in any inflation, assuming the contract and actual curves for labor and material coincided. Investigation of the contractors' actual investment in work in progress has revealed that the contractor has little or no financial investment because he can delay payment to his various suppliers but receives progress payments as the work is performed [11]. This has the advantage to both the contractor and the government of avoiding costs of interest or other capital costs. However, these costs are borne by someone and the procedure has a certain public relations cost, witness the recent furor over the three million dollars Gruman earned on its advance payment. Therefore the Navy has issued instructions changing the progress payments to "dollar progress" as defined below [12].

> Dollar Progress: A term that represents the contractor's cost which shall include only those recorded costs which result from payment made by cash, check, or other form of actual payment for items or services purchased directly for the contract, together with costs incurred, but not necessarily paid, for materials which have been issued from the contractor's stores inventory and placed in the production process for use on the contract, for direct labor, for direct travel, for other direct inhouse costs, and for properly allocated and allowable indirect costs, all as shown by records maintained by the contractor for purposes of obtaining payment under a shipbuilding contract.

The effect of the above change on the escalation provision is not yet clear since no shipbuilding contracts have included the new provision and its actual inclusion is in doubt.

F. SUMMARY

The base period for measurement of escalation should slightly precede to the beginning of the contract. Frequency of measurement will be limited by availability of indices and

he administrative costs. The fixed payment curve of current shipbuilding escalation provides some incentive for shipbuilders to complete their work, suggesting that if escalation is to be based instead on cost incurred, some additional penalty should be assessed in order to retain the incentive for completion. The penalty resulting from freezing the measurement on the scheduled completion date would vary greatly with the rate of inflation, which cast doubt on this incentive technique. Finally, progress payment complicate handling of escalation.

V. HOW SHOULD THE CONTRACTOR BE COMPENSATED?

Once the actual price change has been measured it would seem straight forward to decide how to compensate the contractor for the price change - simply pay him an amount equal to the observed change. However, certain questions do arise:

1. Should the contractor "share" in the risk and therefore should the escalation payment be less than the measurement?

2. If the cost in an incentive contract is above target should the contractor share in the escalation in the cost above target?

3. If the measurement is based on industry or "average" price changes, should the contractor be given an adjustment in the escalation payment?

These questions will be dealt with in turn.

The argument given in Chapter I would indicate that both parties benefit to the extent that the contractor's uncertainty concerning price is eliminated. It was pointed out that he will "contingency price" at additional expected cost to the government if he is forced to face the uncertainty. Therefore deliberate attempts to make the contractor bear part of the risk are contradictory to the reason for the escalation clause. This reasoning would argue against the "abnormal" escalation clause which contains a provision for the contractor to carry "normal" escalation which he then will merely add to his cost estimate as a contingency.

The second question poses the same difficulty plus does not seem to be a reliable penalty for exceding the cost target. If the contractor misestimates the cost of the contract should he be penalized more in times of high inflation? Recent experience would indicate exactly the opposite. The government

has seriously been looking for ways to relieve such penalties yet the Navy is considering writing new escalation clauses containing provisions which would increase the penalty for misestimation in today's circumstances. If no inflation occurs, no additional penalty would be incurred by the contractor even though he has a large cost overrun. Thus sharing in escalation above target seems particularly inappropriate.

Finally there is the question of departure of one contractor's cost from the measurement. Somewhat recently Newport News was allowed a clause with escalation payments based on a multiple of the industry BLS shipbuilding labor index but limited by their own experience as reported to BLS. This is an interesting approach which comes closer to the composite of actual cost method of measurement with indexation. However, it would probably be better to use actual cost as a measurement technique than to multiply the measured price change by an arbitrary factor. The nature of any adjustment should be quite obvious and strongly backed by experience which cannot be modified by the contractor or general economic conditions. For example the clause referred to above was negated by a change in the employment turn-over rate at the shipyard.

In conclusion it would appear that excursions away from a direct compensation for measured price changes will be difficult to accomplish without disturbing the benefits of an escalation provision. It also appears that as an incentive to completion of the contract within target cost, sharing in the price change will penalize the contractor for exceeding target cost only to the extent inflation occurs. This would seem to be a capricious approach.

VI. CONCLUSION

This paper has delineated the issues and choices involved in contract escalation. These are summarized in the Executive Summary. The reader should review the Executive Summary again at this point. The major conclusions of this paper are threefold.

1. Escalation is a desireable choice over contingency pricing when the change in price level is uncertain over the life of the contract.

2. Care must be exercised to reach a proper tradeoff between administrative cost accuracy and moral hazard in the construction of the measurement of change is price level. However no evidence was found that this trade off is not satisfactorily reached at this time.

3. Certain changes in the traditional Navy escalation provision and in the newly proposed provision would allow even more reduction of uncertainty without major increases in administrative cost or moral hazard.

a. Elimination of fixed material and labor progress curves for determining escalation as is now proposed.

b. Allowing escalation of all costs including fee, as is inherent in contingency pricing.

c. Refraining from the proposed "freezing" of escalation at the delivery date.

d. Refraining from requiring the contractor to "share" in escalation.

Several questions which we intend to address later in the research program should now be crossing the reader's mind, having grown from this consideration of the issues and choices.

1. How can a particular set of escalation provisions be evaluated for a particular contract under circumstances of interest to the Navy? A model has been proposed and used in one ship procurement and is now being generalized.

2. Can general, quantitative statements of the response of the contractor to escalation provisions be made? The crude model of this paper which indicates the superiority of escalation is being rigorously developed and extended.

3. What is the relationship between escalation for contracts and the budgetary process, the relationship to DOD profit policy, the relationship to the progress payments policy etc., that have not yet been explored.

These questions are subject to additional research.

REFERENCES

1. U.S. Department of Defense, Defense Procurement Circular, No. 120, 11 March 1974.

2. Jai-Hoon Yang, "The Case for and Against Indexation: An Attempt at Perspective," Federal Reserve Bank of St. Louis Review, Vol. 56, No. 10, October 1974, p. 2.

3. Heller, Walter H., Wall Street Journal, June 20, 1974.

4. Logistics Management Institute, Task 67-4, Revised, Wage Rate and Material Price Level Adjustment Provisions in DOD Procurement, May 1968.

5. Arthur E. Burns, "Profit Limitation: Regulated Industries and the Defense Space Industries," Bell Journal of Economics and Management Science, Vol. 3, No. 1, Spring 1972, p. 3.

6. W. Stanfield Johnson, Statement before subcommittee on Government Procurement, Senate Small Business Committee, 1974.

7. F. Trowbridge Von Baur, Statement before the Proxmire Subcommittee on Economy in Government of the Joint Economic Committee, May 20, 1970.

8. General Accounting Office, Report to the Joint Economic Committee Congress of the United States B-159896, Feasibility of Constructing Price Indexes For Weapon Systems, 10 April 1972, p. 5-54.

9. Hazlett, H.L., The Determinants of Cost Escalation in the Aerospace Industry, Ph.D. Thesis, The George Washington University, Washington, D.C. May 1974.

10. U.S. Department of Defense, Defense Procurement Circular, No.94, 22 Nov 1971.

11. Industry Advisory Council, Report to the Department of Defense Industry Contract Financing, Washington, D.C. June 1971.

12. Secretary of the Navy, SECNAV INST 7810.11, Washington,D.C. 15 March 1973.

13. Marshall, Clyde, Study Report on Escalation in Navy Contracts, NAVMAT-02, 1974.

14. Arrow, K. J., Aspects of the Theory of Risk Baring, Helsinki, 1965.

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